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Effect of pre-sowing seed treatments and sowing time on nursery performance of *Acacia modesta* Wall.

Sourav Singh • Kamal Kishor Sood

Sher-e-Kashmir University of Agricultural Sciences and Technology-Jammu, Main Campus-Chatha, Jammu 180009 Jammu and Kashmir, India

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ABSTRACT

The present study on the effect of pre-sowing seed treatments and sowing time on germination and growth of *Acacia modesta* was carried out in the Division of Agroforestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha, during the year 2021 to improve germination and obtain better quality seedling of *Acacia modesta*. The experiment was laid out in Factorial CRD. The study consisted of nine pre-sowing treatments: soaking in cold water for 48 hours, soaking in boiling water for two minutes, acid scarification with conc. H_2SO_4 for 5 minutes, 10 minutes and 15 minutes, cow dung slurry for one month, cow dung slurry for one and half month, nicking, control, and two sowing time (08th March and 24th March). There was no germination two pre-sowing seed treatments *i.e.* cow dung slurry for one month and, cow dung slurry for one and half month. Also, there was no germination in interactions: acid scarification with conc. H_2SO_4 for 10 minutes x sowing of 08th March, acid scarification with conc. H_2SO_4 for 15 minutes x sowing of 08th March, cow dung slurry for one month x sowing of 08th March, cow dung slurry for one and half month x sowing of 08th March, cow dung slurry for one month x sowing of 24th March and cow dung slurry for one and half month x sowing of 24th March). Amongst pre-sowing treatments, (nicking) had highest germination percentage (65.83%) which was statistically superior to the remaining treatments. The treatment nicking x sowing date of 24th March exhibited the highest value for most of the seedling parameters. Based on the study it can be concluded that nicking followed by sowing on 24th March be carried out to obtain higher germination and better quality of seedlings.

1. Introduction

The world's forest plays an important role in benefitting overall inhabitants and overall health of the planet. Forests are important global resources that provide a wide range of environmental, social and economic benefits (Pourtaghi *et al.*, 2014). In developing countries like India, the growing demands of fuel wood and timber can be fulfilled by growing trees in areas outside the conventional forest and on the farm land. Forest provide a variety of valuable product, such as timber, fuel wood, fiber and non-wood forest products which contribute to the livelihood of rural communities. Nowadays, preference is being given to suitable indigenously growing and nitrogen fixing trees in afforestation and agroforestry programmes. Genus *Acacia* falls in such category which is widely dominated in tropical, subtropical and semi-arid areas throughout the world. Species of *Acacia* are of considerable social and economic importance in many regions of the world. *Acacia spp.* are currently attracting great interest due to their drought resistance and multiple uses such as fodder, wood and non-wood products (gums, resins, and pharmaceuticals) for the local communities, provision of shade and live fencing, and in maintaining soil fertility through nitrogen fixation.

Acacia modesta, commonly known as Phulai, is a member of the family Fabaceae (also called Leguminosae) and sub-family Mimosaceae. It is a deciduous, slow-growing small tree with thorny young shoots and dark brown and black wood. This tree occurs commonly in the dry outer hills and

*Corresponding author: kksood_2000_2000@yahoo.com

valleys in the sub Himalayan tract and outer Himalayas from Yamuna westwards through Haryana, Himachal Pradesh and Punjab up to Jammu. It is a multipurpose tree used as fodder, fuel, agricultural implements, hedge, apiculture and gum. It is also used for cart-wheels and house construction. Its pleasing silky green twigs are also preferred as tooth brushes. In natural forests, *Acacia modesta* have a 30-year felling cycle. In nursery conditions it can be propagated by seeds, young shoots are typically used to supplement grass during the dry season. Regeneration of this species is endangered due to improper, uncontrolled harvesting, lack of conservation measures and continuous encroachment of forest land.

2. Materials and Methods

Study site

The present study was conducted at the experimental farm of the Division of Agroforestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu) under open nursery conditions during the period from March, 2021 to July, 2021.The experimental site is situated in subtropical, Jammu region of Union Territory of Jammu and Kashmir located at an altitude of 332 m above mean sea level with 32° 40′ N latitude and 74° 58′ E longitude. Jammu being a subtropical region experiences hot dry summers, humid rainy season and cold winter months. The summer season usually starts from April and lasts up to June. The maximum temperature rises upto 45°C during May to June and minimum falls to 1°C during winter. The average annual rainfall ranges from 1000-1200 mm with 75-80% of which is received during July to September and rest 20-25% during winter months of December to February.

Experimental layout and conduct

The experiment was laid out in Factorial CRD (Complete Randomized Design) (Table 1).

Nine pre-sowing treatments (soaking in cold water for 48 hours, soaking in boiling water for two minutes, acid scarification with conc. H_2SO_4 for 5 minutes, acid scarification with conc. H_2SO_4 for 10 minutes, acid scarification with conc. H_2SO_4 for 15 minutes, soaking in cow dung slurry for one month, soaking in cow dung slurry for one and half month, nicking, control-no treatment and two sowing dates (08th March 2021 and 24th March 2021). In total, there were eighteen treatment combinations/interactions (Table 1). There were three replications in experiment. There were 10 polybags of size 16 cm x 24 cm per treatment per replication.

Table 1. Pre-sowing treatments, dates of sowing and interactions

Treatments (Interactions)	Pre-sowing treatments	Sowing date
$T_1(P_1D_1)$	P_1 (Soaking in cold water for 48 hours)	D_1 (08 March)
$T_2(P_2D_1)$	P_2 (Soaking in boiling water for two minutes)	D_1 (08 March)
$T_3(P_3D_1)$	P_3 (Acid scarification with conc. H_2SO_4 for 5 minutes)	D_1 (08 March)
$T_4(P_4D_1)$	P_4 (Acid scarification with conc. H_2SO_4 for 10 minutes)	D_1 (08 March)
$T_5(P_5D_1)$	P_5 (Acid scarification with conc. H_2SO_4 for 15 minutes)	D_1 (08 March)
$T_6(P_6D_1)$	P_6 (Cow dung slurry for one and half month)	D_1 (08 March)
$T_7(P_7D_1)$	P_7 (Cow dung slurry for one month)	D_1 (08 March)
$T_8(P_8D_1)$	P_8 (Nicking)	D_1 (08 March)
$T_9(P_9D_1)$	P_9 Control (no treatment)	D_1 (08 March)
$T_{10}(P_1D_2)$	P_1 (Soaking in cold water for 48 hours)	D_2 (24 March)
$T_{11}(P_2D_2)$	P_2 (Soaking in boiling water for two minutes)	D_2 (24 March)
$T_{12}(P_3D_2)$	P_3 (Acid scarification with conc. H_2SO_4 for 5 minutes)	D_2 (24 March)
$T_{13}(P_4D_2)$	P_4 (Acid scarification with conc. H_2SO_4 for 10 minutes)	D_2 (24 March)
$T_{14}(P_5D_2)$	P_5 (Acid scarification with conc. H_2SO_4 for 15 minutes)	D_2 (24 March)
$T_{15}(P_6D_2)$	P_6 (Cow dung slurry for one and half month)	D_2 (24 March)
$T_{16}(P_7D_2)$	P_7 (Cow dung slurry for one month)	D_2 (24 March)
$T_{17}(P_8D_2)$	P_8 (Nicking)	D_2 (24 March)
$T_{18}(P_9D_2)$	P_9 Control (no treatment)	D_2 (24 March)

For recording data, two plants per treatment per replication were chosen using simple random sampling with replacement method. Further due to the non-germination of the certain treatments, all parameters except germination percent were analyzed using CRD, considering each interaction as a single treatment. Germination percentage was analysed using factorial CRD design. The observation recorded were: germination percentage, coefficient of velocity of germination, germination rate index, mean germination time, collar diameter (mm), seedling height (cm), number of leaves, length of primary root (cm), number of secondary roots, fresh shoot weight (g), dry shoot weight (g), fresh root weight (g), dry root weight (g), total seedling fresh weight (g), total seedling dry weight (g), root: shoot ratio (dry weight basis), seedling quality index and sturdiness quotient. The final seed germination was recorded 25 days after sowing when no further germination took place and all other observations were recorded on June 25, 2021. The shoots and roots of sampled plants were dried in hot air oven at 65°C for 48 hours to obtain respective dry weights. After drying, the shoot and root weights of each sampled seedling were recorded using digital electronic balance.

Sturdiness quotient was calculated by using the formula given by Rollar (1977):

$$\text{Sturdiness quotient} = \frac{\text{Height of seedling (cm)}}{\text{Root collar diameter (mm)}}$$

Seedling quality index was estimated by using the formula given by (Dickson *et al.* 1960):

$$\text{Seedling quality index} = \frac{\text{Total dry weight for seedling (g)}}{\frac{\text{Height (cm)}}{\text{Collar diameter (mm)}} + \frac{\text{Shoot dry weight (g)}}{\text{Root dry weight (g)}}}$$

Coefficient of velocity germination (CVG) was calculated according to the Jones and Sanders(1987):

$$CVG = \frac{\sum Ni}{\sum NiTi} X\ 100$$

where Ni = Number of seed germination on i^{th} day (i = 1, 2, 3….x)

Ti = Number of days from the start of the experiment (i = 1, 2, 3…..x)

Germination rate index was estimated by using the formula given by Esechie (1994):

$$GRI = \sum \frac{Gi}{i}$$

where G_i = Germination percentage on i^{th} day (i = 1, 2, 3….x)

The mean germination time (MGT) was calculated according to Orchard (1977):

$$\text{Mean Germination Time (MGT)} = \frac{\sum NiTi}{\sum Ni}$$

where, Ni= Number of seeds germinated on i^{th} day (i = 1, 2, 3….x)

T_i= Number of days from start of the experiment (i = 1, 2, 3...x)

The data was analyzed using the technique of analysis of variance (ANOVA) in accordance with procedure outlined by Gomez and Gomez (1984). The effect of different treatments was tested at 0.05 level of significance. For percent data on germination, arcsine transformation was done.

Seed collection, sowing and after care

A survey was carried out during December to January 2021 to identify the trees for collection of pods. Three healthy trees bearing sufficient number of pods were marked for collection of seeds in village Raipur of Ghagwal, district Samba J&K during December-January 2021. Pods were collected by hand picking from selected healthy trees in February, 2021. These pods were dried in shade for a month and seeds were extracted by hands from the pods. The soil for the experiment was collected from nursery of Division of Agroforestry, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu. The soil was sandy loam in texture (Rana and Sood, 2012). Soil was sieved to remove unwanted material like plant parts, pebbles and weeds. The soil was mixed with sand and FYM in ratio of 1:1:1. The pre-treated seeds were sown in the nursery in these polythene bags on the prescribed dates. Light irrigation was applied immediately after each sowing. Thereafter weeding and watering was carried out as per requirement till the end of the experiment.

3. Results

Germination parameters

The pre-sowing treatments significantly affected seed germination (Table 2).

Table 2. Effect of pre-sowing seed treatments and sowing dates on germination percentage

Treatments	Pre-sowing treatments	Sowing date	Mean
T_1	P_1 (Soaking in cold water for 48 hours)	D_1 (08March)	58.33 (49.81)
T_2	P_2 (Soaking in boiling water for two minutes)	D_1 (08March)	55.00 (47.94)
T_3	P_3 (Acid scarification with conc. H_2SO_4 for 5 minutes)	D_1 (08 March)	48.33 (44.02)
T_4	P_4 (Acid scarification with conc. H_2SO_4 for 10 minutes)	D_1 (08 March)	00.00 (00.00)
T_5	P_5 (Acid scarification with conc. H_2SO_4 for 15 minutes)	D_1 (08 March)	00.00 (00.00)
T_6	P_6 (Cow dung slurry for one month)	D_1 (08 March)	00.00 (00.00)
T_7	P_7 (Cow dung slurry for one and half month)	D_1 (08 March)	00.00 (00.00)
T_8	P_8 (Nicking)	D_1 (08 March)	65.00 (53.84)
T_9	P_9 Control (no treatment)	D_1 (08 March)	35.67 (36.64)
T_{10}	P_1 (Soaking in cold water for 48 hours)	D_2 (24 March)	55.00 (47.87)
T_{11}	P_2 (Soaking in boiling water for two minutes)	D_2 (24 March)	53.33 (46.90)
T_{12}	P_3 (Acid scarification with conc. H_2SO_4 for 5 minutes)	D_2 (24 March)	55.00 (47.86)
T_{13}	P_4 (Acid scarification with conc. H_2SO_4 for 10 minutes)	D_2 (24 March)	51.67 (45.94)
T_{14}	P_5 (Acid scarification with conc. H_2SO_4 for 15 minutes)	D_2 (24 March)	41.67 (40.16)
T_{15}	P_6 (Cow dung slurry for one month)	D_2 (24 March)	00.00 (00.00)
T_{16}	P_7 (Cow dung slurry for one and half month)	D_2 (24 March)	00.00 (00.00)
T_{17}	P_8 (Nicking)	D_2 (24 March)	66.67 (54.72)
T_{18}	P_9 Control (no treatment)	D_2 (24 March)	33.33 (35.23)

	Pre-sowing treatments									Sowing dates	
	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	D_1	D_2
Mean	56.67 (48.86)	54.17 (47.42)	51.67 45.94)	25.83 (22.97)	20.83 (20.08)	0 (0)	0 (0)	65.83 (54.28)	34.05 (34.30)	30.93 (26.84)	41.85 (36.71)

Effect	$CD_{0.05}$	±SE(m
Pre-sowing treatments (P)	3.62 (2.11)	1.77 (2.20)
Sowing date (D)	7.68 (4.49)	3.77 (2.20)
Treatment (P) x Sowing date (D)	10.86 (6.35)	5.33 (3.11)

Figures in brackets are angular transformed values

The highest germination (65.83%) was observed in nicking which was statistically superior to remaining pre-sowing treatments. Further there was no germination in cow dung slurry for one month and cow dung slurry for one and half month.. Sowing date D_2 (24th March) had significantly higher germination (41.85%) than 30.93% in D_1 (08th March).The interaction effect of pre-sowing treatment x sowing date was also significant with respect to germination percentage of seeds. The maximum germination (66.67%) was observed in interaction P_8D_2 (nicking x 24th March) which was statistically at par with P_1D_1 (soaking in cold water for 48hours x 08th March) and P_8D_1 (nicking x 08thMarch) but statistically superior to all the remaining fifteen interactions (Table 2).

The coefficient of velocity of germination, germination rate index and mean germination time of the seedling were also significantly influenced by the treatments (Table 3). The coefficient of velocity of germination (23.64) was highest in T_{17} (nicking and sowing of 24th March) which was statistically at par with T_{10} (soaking in cold water for 48 hours and sowing of 24thMarch), T_{12} (acid scarification with conc. H_2SO_4 for 5 minutes and sowing of 24thMarch), T_{13} (acid scarification with conc. H_2SO_4 for 10 minutes and sowing of 24th March), respectively.

Table 3. Effect of pre-sowing treatment and sowing date on germination parameters

Treatments	CVG	GRI	MGT
T_1-Soaking in cold water for 48 hours x 08th March	13.75	11.40	7.09
T_2-Soaking in boiling water for two minutes x 08th March	14.07	9.54	7.21
T_3-Acid scarification with conc. H_2SO_4 for 5 minutes x 08th March	17.99	8.83	5.78
T_4-Acid scarification with conc. H_2SO_4 for 10 minutes x 08th March	-	-	-
T_5-Acid scarification with conc. H_2SO_4 for 15 minutes x 08th March	-	-	-
T_6-Cow dung slurry for one and half month x 08th March	-	-	-
T_7-Cow dung slurry for one-month x 08th March	-	-	-
T_8 -Nicking x 08th March	17.45	11.95	5.74
T_9-Control (no treatment) x 08th March	15.62	11.94	7.54
T_{10}-Soaking in cold water for 48 hours x 24th March	21.37	14.74	5.26
T_{11}-Soaking in boiling water for two minutes x 24th March	17.07	10.06	5.90
T_{12}-Acid scarification with conc. H_2SO_4 for 5 minutes x 24th March	21.35	12.20	4.73
T_{13}-Acid scarification with conc. H_2SO_4 for 10 minutes x 24th March	20.64	11.98	4.88
T_{14}-Acid scarification with conc. H_2SO_4 for 15 minutes x 24th March	18.67	10.39	5.43
T_{15}-Cow dung slurry for one and half month x 24th March	-	-	-
T_{16}-Cow dung slurry for one month x 24th March	-	-	-
T_{17}-Nicking x 24th March	23.64	19.41	4.65
T_{18}-Control (no treatment) x 24th March	18.61	11.49	7.46
Treatments	**CVG**	**GRI**	**MGT**
$CD_{0.05}$	4.39	3.71	1.29
±SE (m)	1.49	1.26	0.43

CVG- Coefficient of velocity of germination, GRI- Germination of rate index, MGT- Mean germination time

The germination rate index (19.41) was maximum in T_{17} (nicking and sowing of 24thMarch) which was statistically superior to all the remaining treatments and mean germination time was significantly influenced by treatments (Table 3). The maximum mean germination time (7.54) was found in T_9 (control and sowing of 08th of March) which was statistically at par with T_{18} (control and sowing of 24th of March), T_2 (soaking in boiling water for two minutes and sowing of 08th of March) and T_1 (soaking in cold water for 48 hours and sowing of 08th of March), respectively. The minimum mean germination time (4.65) was recorded in T_{17} (nicking and sowing of 24th of March). This was statistically at par with T_{12} (acid scarification with conc. H_2SO_4 for 5 minutes), T_{13} (acid scarification with conc. H_2SO_4 for 10 minutes), T_{10}(soaking in cold water for 48 hours and sowing of 24th of March), T_{14}(acid scarification with conc. H_2SO_4 for 15 minutes and sowing of 24th of March), T_8 (nicking and sowing of 08th of March), T_3(acid scarification with conc. H_2SO_4 for 5 minutes and sowing of 08th of March) and T_{11}(soaking in boiling water for two minutes and sowing of 24th of March), respectively.

Above ground parameters

The seedling height, number of leaves and dry shoot weight were significantly influenced by the treatments (Table 4).

Table 4. Effect of pre-sowing treatments and sowing dates on above ground parameters of seedlings

Treatments	SH (cm)	CD (mm)	NL	FSW (g)	DSW (g)
T_1-Soaking in cold water for 48 hours x 08th March	43.40	3.80	47.67	5.82	2.87
T_2-Soaking in boiling water for two minutes x 08th March	32.23	3.84	54.00	4.13	1.49
T_3-Acid scarification with conc. H_2SO_4 for 5 minutes x 08th March	21.87	3.60	29.00	3.79	1.27
T_4-Acid scarification with conc. H_2SO_4 for 10 minutes x 08th March	-	-	-	-	-
T_5-Acid scarification with conc. H_2SO_4 for 15 minutes x 08th March	-	-	-	-	-

T_6-Cow dung slurry for one and half month x 08th March	-	-	-	-	-
T_7-Cow dung slurry for one-month x 08th March	-	-	-	-	-
T_8 -Nicking x 08th March	42.27	4.23	34.33	4.40	1.12
T_9-Control (no treatment) x 08th March	38.03	3.92	22.67	3.05	1.68
T_{10}-Soaking in cold water for 48 hours x 24th March	39.60	3.81	47.00	6.60	3.19
T_{11}-Soaking in boiling water for two minutes x 24th March	35.47	3.47	47.00	8.08	3.73
T_{12}-Acid scarification with conc. H_2SO_4 for 5 minutes x 24th March	42.13	3.44	50.00	5.14	2.48
T_{13}-Acid scarification with conc. H_2SO_4 for 10 minutes x 24th March	42.57	4.39	47.00	7.74	3.60
T_{14}-Acid scarification with conc. H_2SO_4 for 15 minutes x 24th March	32.80	4.07	39.00	7.64	3.77
T_{15}-Cow dung slurry for one and half month x 24th March	-	-	-	-	-
T_{16}-Cow dung slurry for one month x 24th March	-	-	-	-	-
T_{17}-Nicking x 24th March	45.17	3.92	59.67	9.25	4.70
T_{18}-Control (no treatment) x 24th March	41.40	3.72	31.00	7.78	3.57
Treatments	**SH**	**CD**	**NL**	**FSW**	**DSW**
CD	11.89	N. S	14.54	N. S	1.91
±SE (m)	4.05	0.23	4.95	1.39	0.65

SH*- Seedling height,* ***CD****-Collar diameter,* ***NL****- Number leaves,* ***FSW****- Fresh shoot weight,* ***DSW****-Dry shoot weight*

In case of collar diameter and fresh shoot weight, the effect was non-significant. The maximum seedling height (45.17 cm), number of leaves (59.67), dry shoot weight (4.70g) was observed in T_{17} (nicking x sowing of 24th March). In case of seedling height, T_{17} (nicking x sowing of 24th March) was statistically at par with T_1 (soaking in cold water for 48 hour and sowing of 08thMarch), T_{13} (acid scarification with conc. H_2SO_4 for 10 minutes and sowing of 24thMarch), T_8 (nicking and sowing of 08thMarch), T_{12} (acid scarification with conc. H_2SO_4 for 5 minutes and sowing of 24thMarch), T_{18} (control and sowing of 24thMarch), T_9 (control and sowing of 08thMarch) and T_{11} (soaking in boiling water for 2 minutes and sowing of 24thMarch), respectively. In case of number of leaves, T_{17} (nicking x sowing of 24th March) was statistically at par with T_2 (soaking in boiling water for 2 minutes and sowing of 08thMarch), T_{12} (acid scarification with conc. H_2SO_4 for 5 minutes and sowing of 24thMarch), T_1 (soaking in cold water for 48 hour and sowing of 08thMarch), T_{11} (soaking in boiling water for 2 minutes and sowing of 24thMarch) and T_{13} (acid scarification with conc. H_2SO_4 for 10 minutes and sowing of 24thMarch) respectively. In dry shoot weight T_{17} (nicking x sowing of 24th March) was statistically at par with T_{14} (acid scarification with conc. H_2SO_4 for 15 minutes and sowing of 24thMarch), T_{11} (soaking in boiling water for two minutes and sowing of 24thMarch), T_{13} (acid scarification with conc. H_2SO_4 for 10 minutes and sowing of 24thMarch), T_{18} (control and sowing of 24thMarch), T_{10} (soaking in cold water for 48 hours and sowing of 24thMarch) and T_1 (soaking in cold water for 48 hours and sowing of 08thMarch) respectively

Belowground parameters

The effect of treatments was significant only in case of length of primary root (Table 5).

Table 5. Effect of pre-sowing treatment and sowing date on below ground parameters

Treatments	**LPR**	**NSR**	**FRW**	**DRW**
T_1-Soaking in cold water for 48 hours x 08th March	15.67	12.00	1.69	0.91
T_2-Soaking in boiling water for two minutes x 08th March	20.00	10.00	1.08	0.49
T_3-Acid scarification with conc. H_2SO_4 for 5 minutes x 08th March	22.67	10.00	1.21	0.61
T_4-Acid scarification with conc. H_2SO_4 for 10 minutes x 08th March	-	-	-	-
T_5-Acid scarification with conc. H_2SO_4 for 15 minutes x 08th March	20.00	10.00	-	-
T_6-Cow dung slurry for one and half month x 08th March	22.67	10.00	-	-
T_7-Cow dung slurry for one-month x 08th March	-	-	-	-
T_8 -Nicking x 08th March	-	-	1.51	0.74
T_9-Control (no treatment) x 08th March	-	-	0.94	0.47
T_{10}-Soaking in cold water for 48 hours x 24th March	-	-	1.24	0.59

T_{11}-Soaking in boiling water for two minutes x 24th March	24.00	13.00	1.85	0.70
T_{12}-Acid scarification with conc. H_2SO_4 for 5 minutes x 24th March	20.67	9.67	1.07	0.55
T_{13}-Acid scarification with conc. H_2SO_4 for 10 minutes x 24th March	27.67	13.00	1.11	0.62
T_{14}-Acid scarification with conc. H_2SO_4 for 15 minutes x 24th March	26.33	12.00	1.52	0.67
T_{15}-Cow dung slurry for one and half month x 24th March	24.67	13.00	-	-
T_{16}-Cow dung slurry for one month x 24th March	23.67	12.67	-	-
T_{17}-Nicking x 24th March	28.00	12.00	2.14	0.75
T_{18}-Control (no treatment) x 24th March	-	-	1.47	0.63
Treatments	**LPR**	**NSR**	**FRW**	**DRW**
$CD_{0.05}$	6.30	N.S	N.S	N.S
±SE (m)	2.14	1.45	0.25	0.11

LPR- Length of primary root, NSR-Number of secondary roots, FRW- Fresh root weight, DRW-Dry root weight

The effect of treatments on number of secondary roots, fresh root weight, and dry root weight was non-significant (Table 5).

The highest (31.33 cm) length of primary roots was recorded in T_{17} (nicking and sowing of 24thMarch) which was statistically at par with T_{14} (acid scarification with conc. H_2SO_4 for 15 minutes and sowing of 24thMarch), T_{10} (soaking in cold water for 48 hours and sowing of 24thMarch), T_{11} (soaking in boiling water for two minutes and sowing of 24thMarch), T_{18} (control and sowing of 24thMarch) respectively.

Whole seedling parameters

The effect of treatments was significant on total seedling fresh and dry weight, root: shoot ratio and sturdiness quotient (Table 6). However, the effect was non significant in case of seedling quality index.

Table 6. Effect of pre-sowing treatment and sowing date on whole seedling parameters

Treatments	**TSFW**	**TSDW**	**RSR**	**SQI**	**SQ**
T_1-Soaking in cold water for 48 hours x 08th March	7.51	3.78	0.33	0.26	11.42
T_2-Soaking in boiling water for two minutes x 08th March	5.22	1.99	0.32	0.18	8.45
T_3-Acid scarification with conc. H_2SO_4 for 5 minutes x 08th March	4.99	1.90	0.50	0.23	6.12
T_4-Acid scarification with conc. H_2SO_4 for 10 minutes x 08th March	-	-	-	-	-
T_5-Acid scarification with conc. H_2SO_4 for 15 minutes x 08th March	-	-	-	-	-
T_6-Cow dung slurry for one and half month x 08th March	-	-	-	-	-
T_7-Cow dung slurry for one-month x 08th March	-	-	-	-	-
T_8 -Nicking x 08th March	5.91	1.86	0.58	0.16	10.08
T_9-Control (no treatment) x 08th March	3.99	2.15	0.29	0.16	9.69
T_{10}-Soaking in cold water for 48 hours x 24th March	7.84	3.67	0.20	0.29	10.39
T_{11}-Soaking in boiling water for two minutes x 24th March	9.93	4.43	0.20	0.27	10.23
T_{12}-Acid scarification with conc. H_2SO_4 for 5 minutes x 24th March	6.21	3.03	0.23	0.18	12.62
T_{13}-Acid scarification with conc. H_2SO_4 for 10 minutes x 24th March	8.85	4.21	0.30	0.25	9.69
T_{14}-Acid scarification with conc. H_2SO_4 for 15 minutes x 24th March	9.16	4.20	0.18	0.25	8.07
T_{15}-Cow dung slurry for one and half month x 24th March	-	-	-	-	-
T_{16}-Cow dung slurry for one month x 24th March	-	-	-	-	-
T_{17}-Nicking x 24th March	11.39	5.45	0.67	0.29	6.10

T_{18}-Control (no treatment) x 24th March	9.25	4.86	0.18	0.27	12.21
Treatments	**TSFW**	**TSDW**	**RSR**	**SQ1**	**SQ**
$CD_{0.05}$	3.93	1.93	0.21	N.S.	2.68
±SE (m)	1.33	0.65	0.07	0.03	0.91

TSFW-Total seedling fresh weight (g), TSDW-Total seedling dry weight (g), R:S- Root: shoot ratio, SQI- Seedling quality index, SQ-Sturdiness quotient

4. Discussion

The effect of pre-sowing seed treatments was significant on germination percentage. Similarly, the effect of sowing date as well as the interaction (pre-sowing treatments x sowing dates) was significant on germination. There was no germination in pre-sowing treatments namely P_6 (cow dung slurry for one month) and P_7 (cow dung slurry for one and half month). Similarly, no germination was recorded in interactions *i.e.* P_4D_1 (acid scarification with conc. H_2SO_4 for 10 minutes and sowing of 08th March), P_5D_1 (acid scarification with conc. H_2SO_4 for 15 minutes and sowing of 08th March), P_6D_1 (cow dung slurry for one month and sowing of 08th March), P_7D_1 (cow dung slurry for one and half month and sowing of 08th March), P_6D_2 (cow dung slurry for one month and sowing of 24th March) and P_7D_2 (cow dung slurry for one and half month and sowing of 24th March). A majority of remaining parameters *i.e.* seedling height, number of leaves, length of primary roots, dry shoot weight, total seedling fresh weight, total seedling dry weight, root: shoot ratio, sturdiness quotient, coefficient of velocity of germination, germination rate index, mean germination time were significantly influenced by the treatments, however, the effect on collar diameter, number of secondary roots, fresh shoot weight, fresh root weight, dry root weight and seedling quality index was statistically non-significant. The values of all these parameters were highest in T_{17} (nicking and sowing of 24th March) where the results were statistically significant. Although the highest values of pre-said parameters (seedling height, number of leaves, length of primary root, dry shoot weight, total seedling fresh weight, total seedling dry weight, root: shoot ratio and coefficient of velocity of germination) was recorded in treatment T_{17} but was statistically at par with respective values in many other treatments except germination rate index. Germination rate index was highest in treatment T_{17} (nicking and sowing of 24th March) which was statistically superior to all the remaining treatments. The highest germination percentage (65.83%) in treatment P_8 (nicking) and highest germination rate index in T_{17} (nicking and sowing of 24th March) may be due to the fact that nicking makes it easier for entry of water and exchange of gases resulting in enzymatic hydrolysis and thus transforming the embryo into a seedling at faster rate (Ayisire *et al.* 2009). Likoswe *et al.* (2008) also stated that nicking helps in breaking physical dormancy of seeds with hard coat which inhibit water uptake and gaseous exchange. The present results are in conformity with work of Ahmad *et al.* (2015); Bhardwaj *et al.* (2003); Fredrick *et al.* (2017) and Missanjo *et al.* (2014) in *Acacia modesta*, *Albizia lebbeck*, *Cassia fistula*, *Dalbergia sissoo* and *Leucaena leucocephala; Albizia lebbeck*; *Faidherbia albida* and *Acacia polyacantha* species, respectively. No germination in pre-sowing seed treatments P_6 (cow dung slurry for one month) and P_7 (cow dung slurry for one) as longer period of dipping in cowdung might have resulted in decaying of embryos. Embryo excision during field work also revealed that many embryos were fully decayed in pre-said seed treatments might have not germinated. These findings also draw support from the study of Hemalatha and Chaudhari (2020) who reported that germination in seeds of *Santalum album* treated with cow dung was quite poor compared to other treatments.

Seedling height and number of leaves also showed significant variations due to different treatment combinations in current study. Maximum seedling height and number of leaves was recorded in treatment T_{17} (nicking and sowing of 24th March) and their values were 45.17 cm and 59.67, respectively. These results are in accordance with those of Missanjo *et al.* (2014) and Bedada *et al.* (2018) in *Acacia polyacantha,* and *Olea europea,* respectively. The effect of treatments on biomass parameters (dry shoot weight, total seedling fresh weight and total seedling dry weight) of *Acacia modesta* seedling were significant. Amongst different treatments in the current study, nicking coupled with sowing of 24th March was found to be most effective in enhancing length of primary roots, dry shoot weight, total seedling fresh weight and total seedling dry weight. Similar results were also reported by Missanjo *et al.* (2014), Bedada *et al.* (2018), Mohamed *et al.* (2021) in *Acacia polyacantha, Olea europea* and *Acacia nilotica,* respectively. The highest value of seedling height, number of leaves and pre-said biomass parameters in T_{17} (nicking and sowing of 24th March) treatment might be due to early initiation of germination on account of faster absorption of water and gaseous exchange coupled with optimum temperature for germination after 24th March and consequently longer period of time for growth compared to remaining treatments. The early germination in treatment T_{17} (nicking and sowing of 24th March) is evident as it had lowest mean germination time in the current study.

The treatments exhibited significant influence on root: shoot ratio. The maximum root: shoot ratio (0.67) was observed in T_{17} (nicking and sowing of 24th March). These results are in conformity the findings of Mohamed *et al.* (2021) who also reported a higher root: shoot ratio with mechanical scarification in their study on *Acacia nilotica* carried out at ICAR-Central Arid Zone Research Institute, Rajasthan. Root: shoot ratio refers to the proportion of root dry weight to the shoot dry weight. It also reflects the capacity of the roots to support the above ground biomass not only for anchorage but also in absorbing nutrients and water from the soil. A high root: shoot ratio indicates high absorption and storage capacity of water, which is an advantage especially in conditions of limited available soil moisture (Takoutsing *et al.* 2016).

The sturdiness quotient was maximum (12.62) in T_{12} (acid scarification with conc. H_2SO_4 for 5 minutes and sowing of 24th March) and minimum (6.10) in T_{17} (nicking and sowing of 24th March). According to Jaenicke (1999), a small sturdiness quotient indicates a sturdy, plant with higher expected chances of survival specially on windy or dry sites. Generally, sturdiness quotient of less than six is desirable Jaenicke (1999). In the current study, none of treatments had sturdiness quotient less than six. Gull (2018) reported sturdiness quotients of greater than six in *Terminalia arjuna* in most of his pre-sowing seed treatments but this is in contrast to studies of Ahmad (2017), Pamei *et al.* (2017) and Rashid *et al.* (2018) who reported sturdiness quotient of less than six in their pre-sowing treatments in *Terminalia bellirica*, *Tectona grandis* and *Jatropa curcas*, respectively.

The effect of treatments on coefficient of velocity of germination (CVG), germination rate index (GRI) and mean germination time (MGT) was significant. The higher CVG values indicates germination rapidity (Jones and Sanders 1987), while higher GRI values indicates higher and faster germinations (Esechi, 1994) and the lower MGT value, the faster a population of germinated seeds (Orchard, 1977). Maximum coefficient of velocity of germination and germination rate index was recorded in T_{17} (nicking and sowing of 24th March) which was 23.64 and 19.41, respectively, while the lowest mean germination time (4.65) was recorded in treatment T_{17} (nicking and sowing of 24th March). The results are in accordance with those of Ibrahim *et al.* (2011) in *Acacia asak*, *Acacia ehrenbergiana, Acacia etbaica, Acacia gerrardii* and *Acacia origena,* respectively. Attiku *et al.* (2021) found that CVG and GRI were highest with mechanical scarification in *Diospyros mespiliformis* while conducting their study at Kebbi State University of Science and Technology, Aliero, Nigeria. The lowest mean germination time with nicking treatment was also reported by Mmolutsi *et al.* (2020) in their study on *Vachellia karroo* carried out at Botswana University of Agriculture and Natural Resources located at Sebele.

5. Conclusions

The most of growth parameters in treatment T_{17} (nicking) were superior in their values, though at par with certain other treatments, but germination rate index was statistically superior in T_{17} (nicking and sowing of 24th March). Overall better growth in T_{17} nicking (nicking and sowing of 24th March) could be due to the fact that nicking makes it easier for entry of water and air into embryo of seeds which results a faster germination and consequently the growth. The optimum temperature during later part of March (March 24th) might have also accelerated germination compared to that of 8th March. Based on the present study it can be concluded that

nicking followed by sowing of seed on 24th March be carried out to obtain higher germination and better quality of the seedlings.

6. REFERENCES

Ahmad Z, Muhammad S, Javed A, Sadar S, Imtiaz Q, Junaid A (2015). Improvement of seed germination in some important multi-purpose leguminous trees of Islamabad Area: An experimental study. Basic Research Journal of Agricultural Science and Review 4: 217-224.

Ahmed, F. 2017. Effect of Size of Plant Containers and Potting Media on the Growth of *Terminalia Bellirica* Rox. M.Sc. Thesis, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu. Jammu and Kashmir, India.

Attiku M, Abdulrahman A, Ambursa AS, Muhammed M, Umar I, Almustapha F, Mohammad AG, Dogo AA (2021). Effect of pre-sowing treatment on the seed emergence of Diospyros mespiliformis. African Journal of Sustainable Agricultural Development 2: 14-17.

Ayisire BE, Akinro LA and Amoo SO (2009). Seed germination and in vitro propagation of Piliostigmathonningii an important medicinal plant. African Journal of Biotechnology 8 (3): 401-404.

Bedada, AB, Amsalu T and Ayele B (2018). Effects of different seed treatments, provenance and size on germination and early establishment of *Olea europaea*. African Journal of Agricultural Research 13 (40): 2163-2172.

Bhardwaj NR, Chandel RS, Pathania N (2003). Effect of pre-sowing treatments on germination behavior and seedling vigor index of *Albizia lebbeck* seeds. Indian Agriculturist 1: 276-278

Dickson A, Leaf AL, Hosner JF (1960). Quality appraisal of white Spruce and White Pine seedling stock in nurseries. Forestry Chronicle 36 (4): 10-13

Esechie H (1994). Interaction of salinity and temperature on the germination of sorghum. Journal of Agronomy and Crop Science 172: 194–199

Fredrick C, Muthuri C, Ngamau K, Sinclair F (2017). Provenance and pre-treatment effect on seed germination of six provenances of *Faidherbia albida* (Delile) A. Chev. Agroforestry Systems 91 (6): 1007-1017.

Gomez, KA, Gomez, AA (1984). Statistically Procedure for Agricultural Research. John Wlley and Sons, New York, U.S.A.

Gull, K (2018). Effect of pre-sowing treatments and fruit size on germination and growth of *Terminalia arjuna*. M.Sc. Thesis, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, India.

Hemalatha, M, Chaudhari, SB (2020). Effect of pre-sowing treatments on seed germination and its parameters in sandalwood (*Santalum album* L.). Journal of Pharmacognosy and Phytochemistry 10 (1): 92-95.

Ibrahim MA, Hashim Ali EA, Thobayet AS, Ismail A (2011). Effects of seed pre-treatment and seed source on germination of five *Acacia spp*. African Journal of biotechnology 10: 159-194.

Jaenicke, H (1999). Good Tree Nursery Practices. Practical Guidelines for Community Nurseries. International Centre for Research in Agroforestry, Nairobi, Kenya.

Jones K, Sanders D (1987). The influence of soaking pepper seed in water or potassium salt solutions on germination at three temperatures. Journal of Seed Technology 11: 97–102

Likoswe MG, Njoloma JP, Mwase WF, Chilima CZ (2008). Effect of seed collection times and pretreatment methods on germination of *Terminalia sericea* Burch. ex DC. African Journal of Biotechnoogy 7(16): 2840- 2846.

Missanjo E, Chioza A, Kulapani C (2014). Effect of pre-treatments to the seed on seedling emergence and growth of *Acacia polyacantha*. International Journals of Forestry Research. 14: 6-9.

Mohamed NMB, Shukla AK, Mehta RS, Keerthika A and Gupta DK (2021). Effect of pre-sowing treatment on seed quality attributes of an endemic agroforestry tree of *Acacia nilotica* subsp. cupressiformis (J. L. Stewart) Ali and Faruqi. Legume Research 10: 1-4.

Mmolutsi GG, Matsuane C and Mojeremane W (2020). Application and use of pre- sowing treatment methods to improve germination of Vachellia karroo(Hayne) Banfi and Galasso. Agriculture and forestry Journal.4 (1): 47-54.

Orchard, T (1977). Estimating the parameters of plant seedling emergence. Seed Science and Technology 5: 61–69.

Pamei K, Larkin A, Kumar H (2017). Effect of different treatments on the germination parameters and seedling quality index of Tectonagrandis (Teak) under nursery condition. International Journal of Chemical Studies 5 (5): 2418-2424

Pourtaghi Z, Pourghasemi H, Rossi, Mauro. (2014). Forest fire susceptibility mapping in the Minudasht forests, Golestan province, Iran. Environmental Earth Sciences 73: 12-15.

Rana, RS, Sood KK (2012). Effect of cutting diameter and hormonal application on the propagation of *Ficus roxburghii* Wall. through branch cuttings. Annals of Forest Research 55 (1): 69-84.

Rashid, M, Rasool M, Lal SB, Masoodi L, Mehboob S (2018). Effect of root trainers' size on quality of seedling production of Jatropha carcus. Journal of Pharmacognosy and Phytochemistry 7 (1): 1551-1554.

Rollar, KJ (1977). Suggested Minimum Standards for Containerized Seedlings in Nova Scotia. Report M-X. Canadian Forestry Services. Department of Environment Information. Frederiction, New Brunswisk, Canada. pp 69.

Takoutsing B, Weber J, Aynekulu E, Martín JAR, Shepherd K, Sila A, Diby L (2016). Assessment of soil health indicators for sustainable production of maize in smallholder farming systems in the highlands of Cameroon. Geoderma, 276: 64-73.

Figure 1. Monthly average temperature of the year 2021

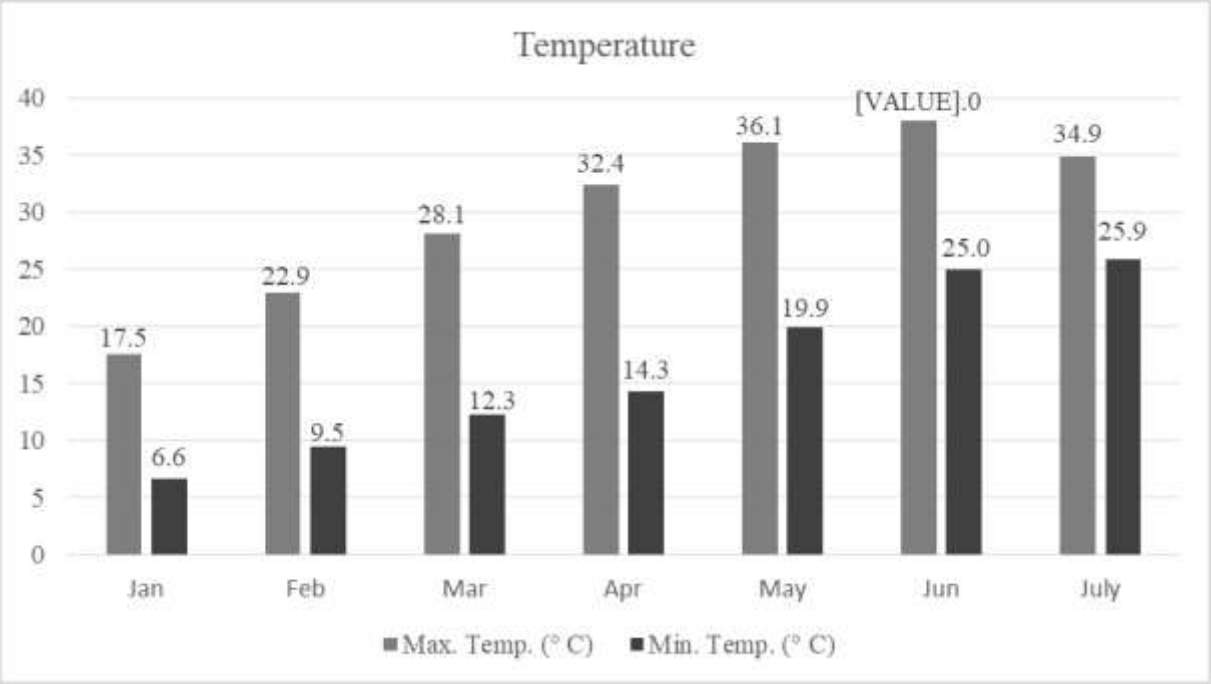

Figure 2. Total month-wise rainfall of the year 2021

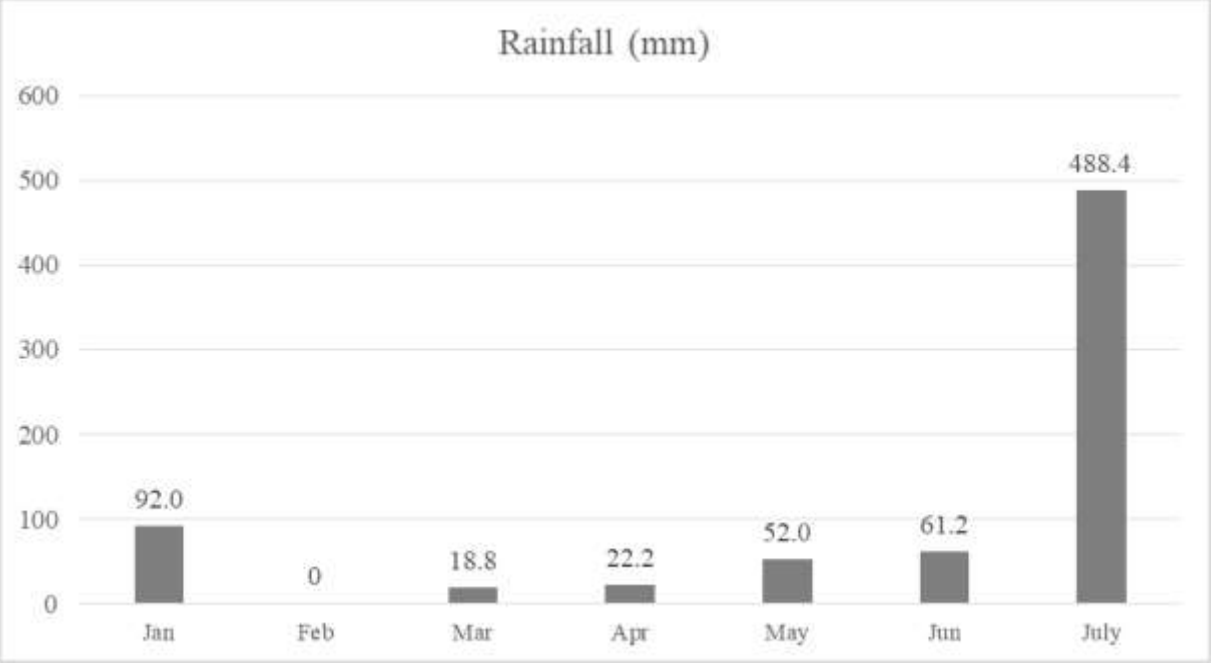

Figure 3. Month-wise average relative humidity of the year 2021